New indicators to measure Biodiversity?

Comparison of biodiversity offset programs implemented by two mining companies in Madagascar

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Summary

In this article we examine the institutional strategies and methods of biodiversity offset calculation employed by two mining companies in Madagascar. Much like the REDD+ mechanisms, these environmental projects are based on past estimations and future predictions, and require validation by international experts. They incorporate a set of standard indicators adapted to the affected habitats, and specially developed units of measurement to demonstrate equivalence. The complex and diverse mitigation portfolios of these companies include aspects of both in-kind and financial compensation, and allow the combination of different types of programs that may be developed directly by the company or delegated to conservation non-governmental organizations (NGOs).

Beyond scientific innovations and institutional strategies, the question remains whether or not these mechanisms will lead to new paradigms and players in conservation or simply become incorporated into existing schemes developed by conservation NGOs and national park authorities.

1. Introduction

As a means for grouping various types of biodiversity offset mechanism under an academic definition, three criteria appear to be particularly relevant: "(1) they provide additional substitution or replacement for unavoidable negative impacts of human activity on biodiversity, (2) they involve measurable, comparable biodiversity losses and gains, and (3) they demonstrably achieve, as a minimum, no net loss of biodiversity. » (Bull, Suttle, Gordon, Singh, & Milner-Gulland, 2013, p371). This definition illustrates the important scientific issues surrounding these mechanisms which must demonstrate, substitute, and measure their positive as well as negative impacts.

Thus, biodiversity offsets depend on scientific argumentation to show that the impacts generated by environmentally intrusive projects are equivalent or less than environmental benefits proposed by the same projects. The need to demonstrate equivalence means that these mechanisms involve the deployment of scientists and experts as well as the development of indicators and metrics suitable for biodiversity measurement. Since the unique aspects of biodiversity can vary greatly from one site to another, biodiversity units are not as easily defined as the measurement of carbon tonnage (ten Kate, Bishop, & Bayon, 2004); and they require studies to compare biodiversity between different sites and to measure (as far as possible) the negative and positive impacts of a project.

Although this new practice is not compulsory in many jurisdictions, it advances actors' interests, and presents advantages such as providing companies with a reinforced "licence to operate", enhancing reputations, and facilitating acquisition of loans with development banks (as explained since 1988 in IFC performance standards or stipulated in the Equator Principles) (ten Kate et al., 2004). Early adoption and proactive participation by companies translates into improved understanding of international policy processes and access to technical guidance in this rapidly evolving field. The two mining companies in Madagascar chose to develop offset programs relatively early and were among the first case studies of the Business and Biodiversity Offsets Programme (BBOP) (Kirsten, 2007), an international platform working to promote international best practice in biodiversity offsets.

The offset strategies being developed around the world are diverse in terms of governance, calculations, collaborations, and even regarding main objectives. The programs of the two companies in Madagascar covered in our study reflect slightly differing objectives; the principal goal of Ambatovy (following the BBOP model) is to deliver "no net loss, preferably a net gain" of biodiversity, while QMM seeks to achieve a "net positive impact" on biodiversity.

Beyond the precise use of terminology, these two projects involve different sets of actors and different calculation methods. What are the strategies developed by these companies to offset the residual environmental impacts caused by their extraction activity? How is this newly manifested interest in conservation by mining companies being institutionalized and advocated? What are the methods used to demonstrate the equivalence between losses and gains? How are these schemes acquiring credibility?

Through a description of the institutional and methodological strategies used by these two firms operating in a country recognized as a "hotspot" of biodiversity, we intend to highlight and explore some of the central issues associated with this new mechanism.

2. Theoretical background

This paper falls into the field of science and technology, and more precisely in the co-production of a scientific and societal framework which allows the symmetrical analysis of social context and scientific construction: "Science, in the co-productionist framework, is understood as neither a simple reflection of the truth about nature nor an epiphenomenon of social and political interests. Rather, co-production is symmetrical in that it calls attention to the social dimensions of cognitive commitments and understandings, while at the same time underscoring the epistemic and material correlates of social formations. Co-production can therefore be seen as a critique of the realist ideology that persistently separates the domains of nature, facts, objectivity, reason and policy from those of culture, values, subjectivity, emotion and politics." (Jasanoff, 2004, p3)

This framework builds on the work of Foucault, who called attention to the links between knowledge and power (Foucault, 1975), and by consequence between science and politics. This understanding facilitates insight into how environmental science and its evolution are woven into political debate and social context (Forsyth, 2003). The concept of biodiversity offsets is imbued with political and economic issues, but scientific argumentation is essential to earn legitimacy as a compensation instrument. Within this context we hypothesize that institutional arrangements, and social issues are just as influential as the ecosystem and science in this process. We will apply this co-productionist framework to biodiversity offsets developed in Madagascar, and detail the choices of governance and methodology used by two companies in order to demonstrate the links between institutional arrangements and scientific knowledge.

Offsets can be broadly classified into three general types (Geraldine Froger & Ménard, submitted):

- ‘In-kind’ offsets are projects developed by the company to establish the ecological equivalence between losses and gains resulting from its activities to demonstrate the final goal of “no net loss” or “net positive impact”.
- ‘Financial offsets are conservation programs financed by the company but implemented by contractors, such as an NGO. The company delegates the responsibility of performance and the program is externally assessed with more emphasis given to the company’s financial contribution than on ecological equivalence.
- Biodiversity Banking is a system based on a supply of biodiversity units, with an intermediary acting between the mining company and the conservation program manager.

In describing the two case studies, we will identify each company by category, and explore their choice of strategy.

3. Methodology and case studies

This article was written during a three-month study for the European project Invaluable. It is rooted in social science methodologies: document reviews, semi-direct interviews, and direct observations in the offset zones of the two mining companies. After describing the national context, we will introduce the case studies.

3.1. National context

Madagascar is a biodiversity hotspot country engaged in the protection of natural resources with an environmental program first developed in the 1980s and since supported by international donors and conservation NGOs (G. Froger & Meral, 2012). Besides its biological resources, the country possesses mining resources representing a major economic opportunity for the development of the country, among the poorest in the world. Two international mining companies are working in Madagascar (see the annex for their main characteristics) and their activities should provide 18% of the fiscal revenues of the country by 2018 (Pelon, 2010). The mining code adopted in 1999 with the help of World Bank was intended to better regulate mining and encourage responsible mining investment (Sarrasin, 2006).

The activities of these mining companies still represent social and environmental risks (Sarrasin, 2006) and may have irreversible impacts (Les amis de la Terre France, 2012; Waeber, 2012). However, following international rules, and with a professed will to go beyond those rules, these two international companies are developing environmental programs to compensate impacts to Malagasy forests incurred by their mining activities.

Being at the same time a biodiversity hotspot and an economically and institutionally weak state, Madagascar remains a priority country for actors of environmental conservation. As demonstrated among NGOs' activities, the Malagasy government is relatively weak compared to other countries, leaving more room for the political manoeuvring useful for developing projects (Hrabanski, Bidaud, Le Coq, & Méral, 2013). The perpetual research of funding for conservation leads those actors to diversify their sources of funding especially through the promoting new approaches such as the conservation of ecosystem services (Bidaud et al., 2013). Biodiversity offsets also represent an opportunity to attract new investment by showcasing the consequential expansion of national protected area systems as a conservation success (Corson, 2011).

3.2. Case studies

3.2.1. QMM and Rio Tinto

QIT Madagascar Minerals (QMM) is a subsidiary of Rio Tinto (20% is owned by the Malagasy government) implanted in the South East of Madagascar. The objective is ilmenite exploitation, a source of titanium dioxide which is used as a whitener in numerous industrial products. The ilmenite is found under littoral sands at a depth of about 12 meters. Three sites, Mandena, Petriky, and Sainte Luce, are planned for exploitation in a perimeter of 40 km near the south-eastern town of Fort Dauphin. These three sites encompass littoral forests which are more or less degraded but which exhibit high biodiversity and levels of endemism, and are the principal subject of the impact studies and biodiversity offsets.

QMM has been involved in Madagascar since 1986 and completed an initial environmental and social impact study in 1992. QMM acquired the environmental permits for Mandena in 2001, and exploitation began at the end of 2008. The initial investments are estimated at around 931 million USD. The exploitation is expected to continue for 40 years from first production.

3.2.2. Ambatovy and BBOP

Ambatovy is an enterprise exploiting laterite ores to produce nickel, cobalt and ammonium sulphate. The company undertakes both extraction and processing of the ore, the first such project in Madagascar and also relatively rare in Africa (QMM's raw material is sent to Canada to be transformed into product). The mine exploitation and the first 2km of the pipeline transporting the ore to the factory require cutting humid forest including forest at the edge of a site designated by Madagascar under the Ramsar convention, making the activity a prime candidate for a best practice biodiversity offset approach.

The environmental permit was awarded in 2006, construction began in 2007, operations in 2010, and commercial production in 2014. The investment to date amounts to about 7 billion USD. The project is expected to operate over a 29 year period.

The two companies have recently developed biodiversity offset programs and represent interesting comparative case studies to examine actors' strategies and approaches to the mitigation of impacts on biodiversity and methods for quantifying losses and gains.

4. Offset calculation and institutional arrangements

4.1. Similar collaborative strategies

Rio Tinto and Ambatovy create partnerships with different actors, but use a similar strategy to develop offset methodology, validate it, and implement conservation projects.

By 1998 Rio Tinto recognized the importance of considering environmental factors to better manage operations and improve access to land (Rio Tinto, 1998). In 1994 the company established a global strategy for biodiversity (Rio Tinto, 2004) which was launched during the IUCN World Congress in Bangkok, and further detailed in a 2008 document (Rio Tinto, 2008).

The Net Positive Impact strategy "means minimizing the impacts of our business and contributing to biodiversity conservation to ensure a region ultimately benefits as a result of our presence." (Rio Tinto 2008, p2).

This strategy was first tested through a conservation program on several sites in Madagascar. It is likely that Rio Tinto's choice to work on conservation in Madagascar has various reasons. First of all, the ilmenite ore is found under littoral forest with high biodiversity value (Bollen & Donati, 2006; Du Puy & Moat, 1996; Ganzhorn, Lowry II, Shatz, & S., 2001), and thus the site represents a very pertinent place to test a biodiversity program. Additionally, campaigns against this mining project emerged in the 1990s (Friends of the Earth, World Development Movement and London Zoo), eventually forcing the company to establish, in 1996, a conservation and environment team (Olegario, Harvey, & Mueller, 2012).

Rio Tinto seems to see the offset program as an opportunity to be showcased as the worldwide leader in environmental issues for extractive industries: "The outcomes of these added benefits are beginning to differentiate us from our competitors and are helping us move towards our goal of being the undisputed sector leader in maximizing value to stakeholders" (Rio Tinto, 2007 cited by Kirsten, 2007).

After joining forces with BBOP during the development of this offset strategy, Rio Tinto then preferred to proceed with its own methodology estimating itself to be more advanced in addressing the issues of this new platform. The strategy of the company was to team up with the International Union for Conservation of Nature (IUCN) through a 3-year collaboration agreement signed in 2010. Two documents have been written (Olsen, Bishop, & Anstee, 2011; Temple et al., 2012); one of them describes the methodology and results of biodiversity quantification on exploitation and conservation zones (Temple et al. 2012), and the other is an economic valuation of protected forests by QMM (but will not be described here).

The main report presenting the scientific argumentation of the Net Positive Impact strategy was written by The Biodiversity Consultancy Ltd. of Cambridge, UK, with support from the environment team of QMM. It has been presented to the biodiversity committee and revised, and then reviewed by several experts from diverse institutions: Hamburg University, Sussex University, Fauna & Flora International, Royal Botanic Gardens Kew, IUCN, UNEP-WCMC, Birdlife International, Conservation international, Wildlife Conservation Society, NatureServe. Twenty-eight people participated in the drafting and the validation of the document.

The strategy is based on a mitigation portfolio: 3 offset zones of forest (2 like-for-like and 1 like-for-not-like), the restoration of exploitation zones, and the avoidance of exploitation. This portfolio is managed by the QMM environment team for some sites (although QMM aims to transfer management progressively to the local community), and by conservation NGOs for other sites. Until now, conservation and restoration zones around the exploitation sites have been managed by QMM while other forests are supervised by conservation NGOs like Missouri Botanical Garden (MBG) and Asity Madagascar (Birdlife International).

By developing its own conservation and restoration programs, but also financing conservation NGOs for the development of specific programs, QMM demonstrates a strategy that includes both in-kind compensation and financial offset. The accounting methods of both programs use the same units of measurement (as described in the following section).

Similarly, in the Ambatovy case we find private sector experts, participation in an international platform, and a portfolio of actions developed by Ambatovy teams or in partnership with NGOs.

The document describing the Ambatovy environmental strategy was written in 2009 by Pierre Berner (Ambatovy), Steven Dickinson (Golder Associates) and Aristide Andrianarimisa (WCS), and takes inspiration from the social and environmental impact study written by Dynatec and Golder Associates in 2006 (Dynatec Corporation of Canada, 2006). The document outlines an accounting method for biodiversity compensation sites that follows BBOP guidelines, and presents a portfolio of environmental responses to mining activities. The portfolio, much like that of QMM, includes a diverse array of ecosystems with programs of mitigation or avoidance, conservation, restoration, and reforestation. These include the Ankerana offset (like-for-like), 3 conservation zones of forest around the mine, restoration of the forest corridor to ensure connectivity, support to the conservation of a Ramsar wetland, reforestation along a section of the pipeline and on the mine footprint, and a program of mitigation before clearance of forest lots. The sites are managed by Ambatovy in collaboration with other NGOs including CI (which is the delegated manager of the Ankeniheny-Zahamena forest corridor (CAZ) of which the Ankerana forest is part) or MBG which conducted research and conservation of endangered flora by mining activities (Ambatovy, 2012). This offset strategy has been cited as an example at the international level (ICMM, 2010).

Despite different sets of actors, we see similar biodiversity strategies in both case studies: offset portfolio diversification, scientific collaboration with international experts, association with well-known organisations or platforms (IUCN for QMM, BBOP for Ambatovy), local partnership with NGOs and research organisations, and conservation and restoration programs managed by the company itself. This diversification of projects and the collaborations improve the company’s credibility in the environmental field, multiplies the chances of successful offset projects and buffers against the effect of individual project failures. The diversity of actions also diffuses radical critics. But even though these strategies may add legitimacy to the companies' biodiversity offset programme, that same diversity also complicates implementation.

4.2. Similar base but different methods

The accounting methods used by QMM and Ambatovy for calculating biodiversity are largely based on the same system of measurement: habitat hectares.

Habitat hectares is a metric developed in Australia by the State Government of Victoria to assess the quantity and quality of vegetation through the evaluation of two main determinants: site condition and viability of patch vegetation. This quantitative method uses a standardised approach to assign individual scores (adjusted to an assigned weight differential) on 10 habitat indicators. Scores are then combined (with a differentiate contribution) to obtain an estimation of the quality of the habitat on a scale from 0 (total loss) to 1 (complete rehabilitation or 100% of "natural quality" as represented by an established "benchmark") (Parkes, Newell, & Cheal, 2003; Victorian Government, 2002). The habitat hectares method has been criticized by McCarthy et al. (2004) for several reasons: potential error among various in-the-field assessments, a lack of consideration given to disturbance regimes, apparent internal inconsistencies and ill-defined procedures. Parkes and his colleagues answer these criticisms by reiterating the rationality of the method which offers a simple, understandable, and useful measure for managers (Parkes, Newell, & Cheal, 2004). Despite the criticisms, the habitat hectare is widely used by companies as a metric in loss-gain calculations.

Both mining companies studied in this article adopted the concept of the habitat hectare method in large part for its simplicity, but they each modified the methodology to their own specifications. BBOP adjusted this method for its pilot projects (Business and Biodiversity Offsets Programme (BBOP), 2012a). In the Ambatovy case, 10 indicators of fauna and flora (table below) are evaluated to determine the hectare quality of the principal offset site. This methodology assessing ten indicators assumes a high degree of similarity between exploitation and conservation sites. The 2009 publication developed this method but a lack of data restricted its complete application, preventing conclusive calculations to prove the achievement of the no net loss objective. Since 2009, three scientific expeditions involving approximately one hundred researchers were conducted in 2010, 2011, and 2012 in order to collect additional data for more complete loss gain calculations (Ambatovy, 2013). A fourth expedition was undertaken in 2014, and the expeditions should provide enough data for Ambatovy to publish results in the near future (Andrew Cooke, pers. comm.).

The compensation principle developed by QMM contends that even in the absence of mining operations, the littoral forest would have been destroyed by the pressure of human activity from the local population. From this perspective they suggest that the restoration and conservation programs, developed by the company will bring a net positive impact on biodiversity at the regional level. To support this argumentation quantitatively, IUCN, The Biodiversity Consultancy and the environment team of Rio Tinto used two metrics: "Quality

Hectare" and "Units of Global Distribution" which are both conceptually linked to the habitat hectares method developed by the State of Victoria.

"Quality hectare" illustrates forest degradation in terms of quantity and quality of the forest cover (Temple et al., 2012, p16). Using the forest cover as the only indicator (as opposed to 10 different indicators) considerably simplifies the method, and does not require a high degree of similarity between the exploitation and conservation sites.

"Units of Global Distribution" is a metric developed specifically for the Madagascar project, but is also linked to quality hectares, and inspired by identification methods for biodiversity conservation's globally important sites under the Ramsar Convention[1]. This metric is also linked to the extinction risk of the IUCN list. The units are calculated according to the presence of species and their global distribution: one unit corresponds to 1% of the global population of the species. The endemicity of the species is reflected in calculations to ensure that Units of Global Distribution can account for impacts on a rare species. The species can be different from one site to another; importance is placed on the consideration of all the species and their rarity[2].

The two metrics allow the evaluation of different types of ecosystems as well as the forest conservation activities developed by QMM and its partners, thus enabling offset comparisons to the biodiversity lost on exploited sites.

Around 10 methods of offset calculation exist in the world (Business and Biodiversity Offsets Programme (BBOP), 2012a, 2012b). In our case studies we have seen that the two companies exploiting ore in Madagascar apply methodologies that are based on the same metric (habitat hectare), but calculate it differently. QMM simplifies the method by using only two indicators, thus allowing them to compare a variety of habitats and compensate for the diminished surface of littoral forests, which is too small to be the only offset. Ambatovy more or less follows the original habitat hectare method, using a similar grid of 10 indicators (depending of the presence of certain species) for degraded and conserved forest. As noted, this requires strong habitat similarity, which additional studies are intended to confirm.

Neither of the methodologies used by the two companies are transformative biological studies. They remain focused on standard species indicators (population numbers and IUCN classification) and the study of forest cover to describe habitat degradation. They are variations on the habitat hectare method developed by the government of Victoria in 2002.

The concept of Ecosystem Services has been on the international conservation agenda for a decade (Millennium Ecosystem Assessment, 2005) but it has not yet been integrated with

[1] « A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of water bird » (Ramsar Convention Secretariat, 2004)
« Similarly, the criteria for the identification of Key Biodiversity Areas (KBAs) use thresholds of 1% or 5% of the species' global population (depending on the type of species in question) to identify Key Biodiversity Areas (Langhammer et al. 2007). » (Temple 2012, Annexe 2 p63)

[2] For instance : « The project is predicted to have a Net Positive Impact on 83/90 High Priority species, comprising a total of +1,256 UD (including like-for like species only) and +c. 1,750 UD (including like-for-not-like High Priority species that are found in the offsets but not on the mine site)." (Temple et al., 2012, p43)

the development of metrics. However current studies are following the lead of international organizations looking for ways to incorporate the concept (Business and Biodiversity Offsets Programme (BBOP), 2012c), particularly with a metric that allows the comparison of ecosystem services among different ecosystems. The mining companies and their consultants are also considering ways to add ecosystem services to the conventional indicators used in their offset calculations.

Classical inventory type measures of biodiversity are being refined through the use of new algorithms that use a process of successive reductions allowing observers to condense the representation of an ecosystem into a few metrics (Latour, 2007 [1999]), thus facilitating the comparison of ecosystems and equivalence proposals. For insiders, terminology such as “net positive impact” is seen as a useful measure to convince corporate decision-makers of the advantages of considering biodiversity and the efficiency of metrics developed through simple but robust scientific arguments. How could a contemporary business manager not appreciate of the advantages of being able to demonstrate positive impact after many years of critical focus on the environmental degradation caused by extractive mining?

5. Discussion

Biodiversity offset mechanisms are rooted in new international practices of conservation, combining financial transfer and reduction of environmental pressures. Standards are found similar to those of REDD+ (Angelsen, 2009; Karsenty, Vogel, & Castell, 2012; Lohmann, 2009):

(1) Classical measures used for new outputs (diameter at breast height to determine carbon tonnage in the case of REDD+, species inventory to determine species distribution units in the case of biodiversity offsets).
(2) A unit metric facilitating demonstration of equivalence (carbon ton, quality hectare, habitat hectare).
(3) Predictions of future positive impact of the project (avoided deforestation) based on estimation of actual losses (using prevailing annual deforestation rates as a baseline).
(4) International experts who evaluate a project. The two cases presented here from Madagascar do not involve an international market mechanism and do not have access to any recognized system of certification such as for REDD+, but endorsement from the international scientific community is sought.
(5) Demonstrated additionality.
(6) The use of new technologies and particularly geographical information and remote Earth Observation systems.

The REDD+ and biodiversity offsetting mechanisms emerged in the same decade (2000) and rest on the construction of scientific argumentation that is relatively similar in terms of methodology (baseline) and governance (international expertise), even though it does not focus on the same object (one on carbon, the other on biodiversity).

Despite the similarities of the scientific argumentation, the implementation of the two mechanisms is very different, notably for local populations who may not view conservation NGOs and mining companies in the same light. In REDD+ projects, emitters from developed countries are paired with conservationists operating in southern countries, but in biodiversity offset projects, the same company is implicated in both the degradation and the conservation. This apparent paradox is not well understood by local actors who are sceptical regarding forest conservation by mining companies. This is may be one reason why companies do not generally work alone on conservation programs but prefer to collaborate with conservation NGOs that bring legitimacy, technical expertise and experience in the field.

Although both mechanisms aim to provide funding for conservation, the respective rationales are different. In REDD+ projects the beneficiary pays while a biodiversity offset project, is funded by the disturber (Boisvert, Meral, & Froger, 2013).

Contrary to a REDD+ mechanism which already fits into the voluntary carbon market, biodiversity offsets are not market-based incentives in practice. Despite a frequent classification as market-based instruments for conservation and ecosystem services, we have not seen any market reference in the two biodiversity offset cases studied. This gap between discourse and practice in Payments for Environmental Services and biodiversity offsets has already been highlighted in the literature (Boisvert et al., 2013).

Finally, despite the requirement additionality for REDD+ projects as well as for biodiversity offsets, both mechanisms are potentially developed on the same zones. This issue may apply to the two case studies:

- The main offset zone of Ambatovy, the Ankerana protected area, is part of the CAZ corridor managed by CI who signed a 2008 agreement with the BioCarbonFund of the World Bank stipulating the purchase of 430 000 carbon credits for 1,5 million USD. This funding is currently being held, waiting for certification and a proposal for benefit sharing with the local community. Although the additionality question has been discussed between Ambatovy and CI, and Ambatovy will cover the percentage of the biocarbon finance attributable to Ankerana, without making claim itself about the Ankerana carbon (Andrew Cooke, personal comm.)
- Rio Tinto has engaged IUCN experts for an economic valuation of ecosystem services from its offset sites. They wrote a document showing that the economic benefits of conservation of the « like-for-not-like » humid forest are particularly important in terms of carbon storage. The document identifies REDD+ as a potential mechanism to fund, at the same time, conservation management by Rio Tinto and the local people living around the forest (Olsen et al., 2011).

5. Conclusion

We have shown here that biodiversity offset strategies of two mining companies in a southern hemisphere country with high biodiversity are different but conceptually linked, and rest on past estimations and future predictions of land use changes. With scientific argumentation similar to REDD+ mechanisms, their calculations help to justify and validate the policy of certain mining companies to claim "no net loss" or "net positive impact" on biodiversity.

We outlined two different but related scientific strategies of the mining companies, which rely on natural factors (characteristics of degraded and conserved ecosystems), and on institutional factors (choice of key collaborations to collect the data and help develop the main argumentation). These initiatives may not be complete solutions, but they allow for better quantitative and qualitative ecosystem assessment and acknowledge and apply new standards developed by the international community on the value of biodiversity. They also encourage the development of funding mechanisms.

Biodiversity offsets are not mandatory for these mining companies, but they are integrated into their respective investments, and supported with strategies that are contextual and diverse in terms of governance and development of scientific argumentation. As international initiatives like BBOP attempt to standardise the indicators and principles of offset programs, a sort of competitive race for biodiversity metrics further motivates firms to invest in this relatively recent concept, as a means of influencing international standards and perhaps reap advantages from leadership in the field.

Beyond these scientific and institutional aspects, biodiversity offsetting represents a new mechanism that has the potential for mobilising resources over extended periods of time when compared with classical conservation projects developed by NGOs. But are those variables (funding and duration) decisive for the sustainability and efficiency of a conservation project? Will this mechanism largely change conservation schemes or become incorporated into the continuity of an assortment of actions? How will this mechanism take into account local populations near conservation zones who rely on natural resources for livelihood and may already live in very precarious conditions?

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Annex: Summary of the main characteristics of the two firms

Companies	Ambatovy	QMM (Qit Madagascar Minerals)
Investment	5.5 billion USD	931 millions USD
Financial partnerships	Dynatec Corporation (Canada), Sherritt Incorporated (Canada), Sumitomo Incorporated (Japan), Kores (Korea) and SNC Lavalin (Canada)	80% Rio Tinto (Canada, Angleterre) / 20% Malagasy Government
Ore	Nickel, Cobalt and Ammonium Sulphate	Ilmenite
Annual taxes in 2012	USD 20 millions	USD 19,8 millions
Exploitation duration	29	40 to 50
Start of exploration	1994	1986
Feasibility and impact studies	2003	1992
Mining permit acquisition	2006	2001
Start of exploitation	2010	2008
First document on offsetting	2009	2012
Calculation methods	Habitat Hectares	Quality Hectares and Unity of Global Distribution
Focus	species, habitats, connectivity	habitat, species
Inspirations of the method	BBOP and Victoria Australia	Victoria Australia, Ramsar Convention
Objective	No Net Loss	Net Positive Impact
Type of compensation	In-Kind Compensation and Financial Compensation	In-Kind Compensation and Financial Compensation
Construction	port ; pipeline ; transformation factory	port ; route
Avoidance area	21 different studied roads for pipeline	1722ha
Restoration area	Ongoing planification	200 (for Mandena site)
Reforestation area	Ongoing planification	1800 (for Mandena site)
Degraded forest area	1352,5	1665
Offset area	27400	20000
Offset area/degraded area	20	12
Number of species (flora)	376	614
Number of endangered species (flora)	3	42
Number of species ()	201	?
Number of endemic species (fauna)	?	12

Number of endangered species (fauna)	15	?
lemurs	16	?
herpetofauna	123	96
birds	62	77
habitats	3 types of habitat and one at landscape level	
Partnership for offset writing	Golder Associates, WCS, Ambatovy	The Biodiversity Consultancy, IUCN, QMM
Scientific partnerships (offset)	MBG, WCS, BBOP	The Biodiversity Consultancy, IUCN
Management partnerships (offset)	MBG, CI	MBG, Asity
Cost of offset	Around US$ 300 000 for Ankerana site (with CI); More than one US$ million for flora conservation program around the mine (with MBG) ; more than US$ 250 000 to quantify losses and gains (with WCS)	600000 for the 3 QMM sites + 20000 to MBG in Mahabo + ? Asity in TGK
Scientific budget	560000	?
Budget for one hectare	35-44$	150-1500
Degraded ecosystem	1336 ha of humid forest + 216km of pipeline equivalent to 16,5ha; **Total loss** : 1168 habitat hectare	**Total loss** : 428 quality hectare
Biodiversity Offset	1) 11600ha endangered forest off-site offset (with similar abiotic and biotic conditions), 2) 2 on-site azonal forest habitats conservation, 3) 4900ha conservation forest area around the footprint, 4) Analamay-Mantadia forest corridor, 5) Ramsar humid zone of Torotorofotsy, 6) Pipeline right of way reforestation, 7) mine footprint replacement forest	**Offset:** Mahabo (like for like), Tsitongambarika (like for not like), Ste Luce (like for like), **Avoidance:** Petriky, Mandena et Ste Luce, **Restoration** : Petriky, Mandena and Ste Luce